Washington State
Department of Transportation

SR 520 / 148th Avenue NE Interchange – Overlake Access Ramp

SR 520

MP 8.75 to MP 9.20

Noise Discipline Report

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Project Objectives

The SR 520 eastbound off-ramp provides access to the Overlake area, spanning the jurisdictions of Redmond and Bellevue, but is severely congested. Despite optimizing the signal timing at the ramp terminal, off-ramp queues regularly extend nearly to the mainline of SR 520 and occasionally back up onto the mainline.

This project will modify the existing off-ramp from eastbound SR 520 to SB 148th Ave NE. It will also construct a new connection from the ramp via tunnel underneath 148th Ave NE that will provide direct access to the Overlake area and 152nd Ave NE. Work will include, but not be limited to, tunnel construction, excavation, paving, retaining walls, striping, traffic control, signing, roadside restoration, illumination, and drainage.

The action triggering this Type 1 noise study is the construction of the new ramp via a tunnel underneath 148th Avenue NE.

Current Noise Environment

The project area is in a mostly commercial corridor in Redmond which includes low-rise office buildings, a school, a paved bike/pedestrian trail and a hotel. Traffic noise from SR 520 and its ramp as well as the 148th St NE main arterial are the primary noise source in the area and results in existing noise levels above the WSDOT Noise Abatement Criteria (NAC). Modeled Existing Condition (2015) traffic noise impacts are predicted at Bellevue Academy School, the SR 520 Bike/Pedestrian trail and 7 commercial offices.

Noise Impacts of Alternatives

Modeled No Build (2035) and Build (2035) traffic noise impacts are identical to Existing Conditions (2015) with impacts at the same school, trail and commercial offices. No substantial increase impacts under No Build (2035) and Build (2035) conditions.

Abatement (Recommended/Not Recommended)

Noise abatement was evaluated at the Bellevue Academy School (both campuses) and the SR 520 bike/pedestrian trail where traffic noise impacts were predicted. At both locations noise barriers were found to be feasible and reasonable. However, the additional cost of relocating utilities for the barrier adjacent to the SR 520 trail makes that barrier not reasonable. The barrier adjacent to the Bellevue Children's Academy is recommended for construction.

Introduction

Project Description

The SR 520 eastbound off-ramp provides access to the Overlake commercial area, spanning the jurisdictions of Redmond and Bellevue, but is severely congested. Despite optimizing the signal timing at the ramp terminal, off-ramp queues can regularly extend nearly to the mainline of SR 520 and occasionally back up onto the mainline itself.

This project will modify the existing off-ramp from eastbound SR 520 to SB 148th Ave NE. It will also construct a new connection from the ramp via tunnel underneath 148th Ave NE that will provide direct access to the Overlake area and 152nd Ave NE. Work will include, but not be limited to, tunnel construction, excavation, paving, retaining walls, striping, traffic control, signing, roadside restoration, illumination, and drainage.

Type 1 Trigger for Noise Analysis

A traffic noise analysis is required by law[1] for federally funded projects and required by state policy[2] for other funded projects that:

- Involve construction of a new highway,
- Significantly change the horizontal or vertical alignment,
- Increase the number of through traffic lanes on an existing highway, or
- Alter terrain to create new line-of-sight to traffic for noise sensitive receivers.

For this project, the construction of the new single lane grade separated slip ramp under 148th Avenue NE is considered a new roadway and so is the trigger for this noise study.

Noise Relevant Project Information

- List of items relevant to traffic noise analysis for existing, No-Build, and Build conditions, include:
    - SR 520 is in a slight cut through the project area
    - There are two general purpose lanes and one HOV lane in each direction
    - SR 520 traffic noise is partially shielded on the north side by 29th Avenue which is at an elevated grade above SR 520
    - A new single lane grade separated slip ramp under 148th Avenue NE will be constructed and the existing off-ramp terminal to southbound 148th Avenue NE

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[1] 23 CFR 772, "Procedures for Abatement of Highway Traffic Noise and Construction Noise"

[2] 2011 WSDOT Traffic Noise Policy and Procedures, WSDOT

will be relocated approximately 100 feet to the north. The new "Overlake Access Slip ramp" will terminate with a new roundabout for a ramp terminal intersection control type.

- The project would maintain current posted speeds
- Year for Existing (2015) and Build/No-Build conditions (2035)

Exhibit 1: Project Vicinity

Characteristics of Sound and Noise

Definition of Sound

Sound is created when objects vibrate, resulting in a minute variation in surrounding atmospheric pressure, called sound pressure. The human response to sound depends on the magnitude of a sound as a function of its frequency and time pattern (EPA, 1974). Magnitude is a measure of the physical sound energy in the air. The range of magnitude the ear can hear, from the faintest to the loudest sound, is so large that sound pressure is expressed on a logarithmic scale in units called decibels (dB). Loudness refers to how people subjectively judge a sound and varies between people.

Sound is measured using the logarithmic decibel scale, so doubling the number of noise sources, such as the number of cars on a roadway, increases noise levels by 3 dBA. Therefore, when you combine two noise sources emitting 60 dBA, the combined noise level is 63 dBA, not 120 dBA. The human ear can barely perceive a 3 dBA increase, while a 5 dBA increase is about one and one-half times as loud. A 10 dBA increase appears to be a doubling in noise level to most listeners. A tenfold increase in the number of noise sources will add 10 dBA.

In addition to magnitude, humans also respond to a sound's frequency or pitch. The human ear is very effective at perceiving frequencies between 1,000 and 5,000 Hz, with less efficiency outside this range. Environmental noise is composed of many frequencies. A-weighting (dBA) of sound levels is applied electronically by a sound level meter and combines the many frequencies into one sound level that simulates how an average person hears sounds of low to moderate magnitude

Definition of Noise

Noise is unwanted or unpleasant sound. Noise is a subjective term because, as described above, sound levels are perceived differently by different people. Magnitudes of typical noise levels are presented in Exhibit 2.

Traffic Noise Sources

An increase in traffic volumes, vehicle speeds, or the amount of heavy trucks will increase traffic noise levels. Traffic noise is a combination of noises from the engine, exhaust, and tires. Defective mufflers, truck compression braking, steep grades, the terrain and vegetation near the roadway, shielding by barriers and buildings and the distance from the road can also contribute to the traffic noise heard at the roadside.

Exhibit 2: Typical Noise Levels

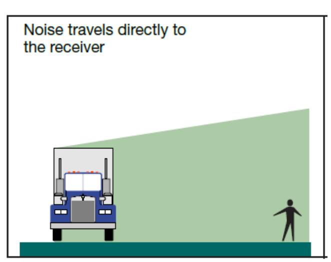
NOISE SOURCE OR ACTIVITY		SUBJECTIVE IMPRESSION	RELATIVE LOUDNESS (human judgment of different sound levels)
Jet aircraft takeoff from carrier (50 feet)	140	Threshold of pain	64 times as loud
50-horsepower siren (100 feet)	130		32 times as loud
Loud rock concert near stage Jet takeoff (200 feet)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 feet)	110		8 times as loud
Jet takeoff (2,000 feet)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 feet)*	90		2 times as loud
Garbage disposal (2 feet) **Pneumatic drill (50 feet)**	80	**Moderately loud**	**Reference loudness**
Vacuum cleaner (10 feet) Passenger car at 65 mph (25 feet)*	70		1/2 as loud
Typical office environment	60		1/4 as loud
Light auto traffic (100 feet)*	50	Quiet	1/8 as loud
Bedroom or quiet living room Bird calls	40		1/16 as loud
Quiet library, soft whisper (15 feet)	30	Very quiet	
High quality recording studio	20		
Acoustic test chamber	10	Just audible	
	0	Threshold of hearing	

Sources: Beranek (1988) and U.S. EPA (1974)

Sound Propagation

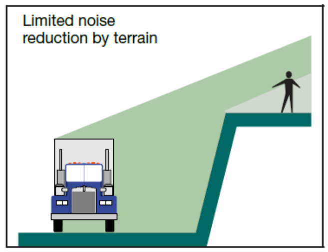
Sound propagation, or how far the sound travels, is affected by the terrain and the elevation of the receiver relative to the noise source. Noise levels can be reduced by breaking the line of sight between the receiver and the noise source.

- Level ground: noise travels in a straight path between the source and receiver.



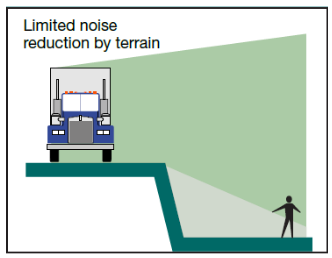
Level Ground

- Depressed source/elevated receiver: terrain may act like a partial noise barrier and reduce noise levels if it crests between the source and receiver.



Depressed source/elevated receiver

- Elevated source/depressed receiver: the edge of the roadway acts as a partial noise barrier. Even a short barrier, like a concrete safety barrier, can reduce



Elevated source/depressed receiver

Line and Point Sources

Noise levels decrease with distance from the noise source. For a line source, like a highway, noise levels decrease 3 dBA for every doubling of distance, e.g., from 50' to 100', between the source and the receiver over hard ground (concrete, pavement) or 4.5 dBA over soft ground (grass). For point source, like most construction noise, the levels decrease between 6 and 7.5 dBA for every doubling of distance.

Effects of Noise

The FHWA noise abatement criteria are based on speech interference, which is a well-documented impact that is relatively reproducible in human response studies. Environmental noise indirectly affects human welfare by interfering with sleep, thought, and conversation. Prolonged exposure to very high levels of environmental noise can cause hearing loss and the Environmental Protection Agency (EPA) has established a protective level 70 dBA $L_{eq}(24)$[3] for hearing loss. Noise also can affect some types of wildlife during certain activities.

[3] U.S. EPA, 1974

Noise Level Descriptors

The equivalent sound level (L_{eq}) is a measure of the average noise level during a specified period of time. A one-hour period, or hourly L_{eq} [L_{eq}(h)], is used to measure highway noise. L_{eq} is a measure of total noise during a time period that places more emphasis on occasional high noise levels that accompany general background noise levels. For example, if you have two different sounds, and one contains twice as much energy, but lasts only half as long as the other, the two would have the same L_{eq} noise levels.

Either the total noise energy or the highest instantaneous noise level can describe short-term noise levels, such as those from a single truck passing by. The sound exposure level (SEL) is a measure of total sound energy from an event, and is useful in determining what the L_{eq} would be over a period in time when several noise events occur. L_{max} is the maximum sound level that occurs during a single event and is related to impacts on speech interference and sleep disruption. L_{min} is the minimum sound level during a period of time.

With L_n, "n" is the percent of time that a sound level is exceeded and is used to describe the range of sound levels recorded during the measurement period. For example, the L_{10} level is the noise level that is exceeded 10% of the time. Sound varies in the environment and people will generally find a higher, but constant, sound level more tolerable than a quiet background level interrupted by higher sound level events. For example, steady traffic noise from a highway is normally less bothersome than occasional aircraft flyovers in an otherwise quiet area.

Noise Regulations and Impact Criteria

Traffic noise impacts occur when predicted L_{eq}(h) noise levels approach or exceed noise abatement criteria (NAC) established by the FHWA, or substantially exceed existing noise levels[4]. WSDOT considers a noise impact to occur if predicted Leq(h) noise levels approach within 1 dBA of the noise abatement criteria. The FHWA noise abatement criteria specify exterior L_{eq}(h) noise levels for various land activity categories as described in Exhibit 3. WSDOT also considers an increase of 10 dBA or more to be a substantial increase and a traffic noise impact. Additional information can be found in Appendix A.

[4] U.S. Department of Transportation, 1982, Noise Abatement Council

Exhibit 3: FHWA Noise Abatement Criteria by Land Use

Activity Category	L_{eq}(h) at Evaluation Location (dBA)	Description of Activity Category
A	57 (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (exterior)	Residential (single and multi-family units)
C	67 (exterior)	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools , television studios, trails, and trail crossings
D	52 (interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72 (exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F. Includes undeveloped land permitted for these activities.
F	-	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G	-	Undeveloped lands that are not permitted

Traffic Noise Analysis Methodology

Determination of the Traffic Noise Study Area

The noise study area was determined using CFR 772 requiring identification of all existing land uses, and undeveloped lands permitted for development that may include noise-sensitive land uses. A 500-foot limit from project improvements was used as a starting point for noise study boundaries and was maintained after field reconnaissance and field measurements identified that 500-feet captured impact distances from this section of SR 520. The noise study limits end at the western and eastern project limits of MP 8.75 and 9.20, respectively and the northern and southern noise study limits end 200 feet from project improvements as shown by the red lines on Exhibit 4.

As shown in Exhibit 4, the noise study area is mostly a commercial corridor in the city of Redmond which includes a variety of land uses. Low-rise office buildings characterize much of the noise study area. A school, a trail and a hotel are located within the noise study area.

Short term noise events from traffic on side streets contribute to the noise environment in the study area; however, the primary noise source throughout much of the study area is from vehicles travelling on SR 520. Throughout much of the noise study area SR 520 is located in a slight cut and is depressed beneath the elevation of nearby parcels.

Exhibit 4: Noise Study Area

Traffic Noise Measurement

Ambient noise levels were measured to identify major noise sources in the project area and validate the noise model. Traffic noise measurements are not used to describe Existing conditions, which are modeled after the noise model has been validated.

15-minute L_{eq} measurements were collected at five locations representative of all sound level environments within the study area during free-flowing traffic conditions. FHWA allows 15-min L_{eq} measurements to represent the L_{eq}(h). These traffic noise measurements are not a representation of “average” existing noise levels.

Traffic Noise Model Validation

To ensure that the noise model used to predict traffic noise impacts accurately reflects the sound levels in the noise study area, a model is constructed using the same traffic volumes, speed, and vehicle types that were present during the sound level measurements. Modeled values must be within ±2.0 dBA of the measured levels for the model to be validated.

FHWA's Traffic Noise Model (TNM) Version 2.5 (FHWA, 2004) was used for validation and to predict future L_{eq}(h) traffic noise levels. TNM calculates precise estimates of noise levels at discrete points. The model estimates the sound levels from a series of straight-line roadway segments. TNM also considers the effects of existing barriers, topography, vegetation, and atmospheric absorption. Noise from sources other than traffic is not included so when non-traffic noise is present, such as aircraft noise, TNM will under predict the actual noise level. To create the model, design files outlining major roadways, topographical features, and sensitive receptors were imported into the TNM model as background features and the corresponding values were entered manually. Aerial photographs and site visits were used to verify site conditions.

Exhibit 5 describes the validation locations and the comparison of measured to model values. Recorded traffic information during the measurements is included in Appendix B. The field sheets from the validation measurements can be found in Appendix C. Exhibit 6 shows the measured receiver locations.

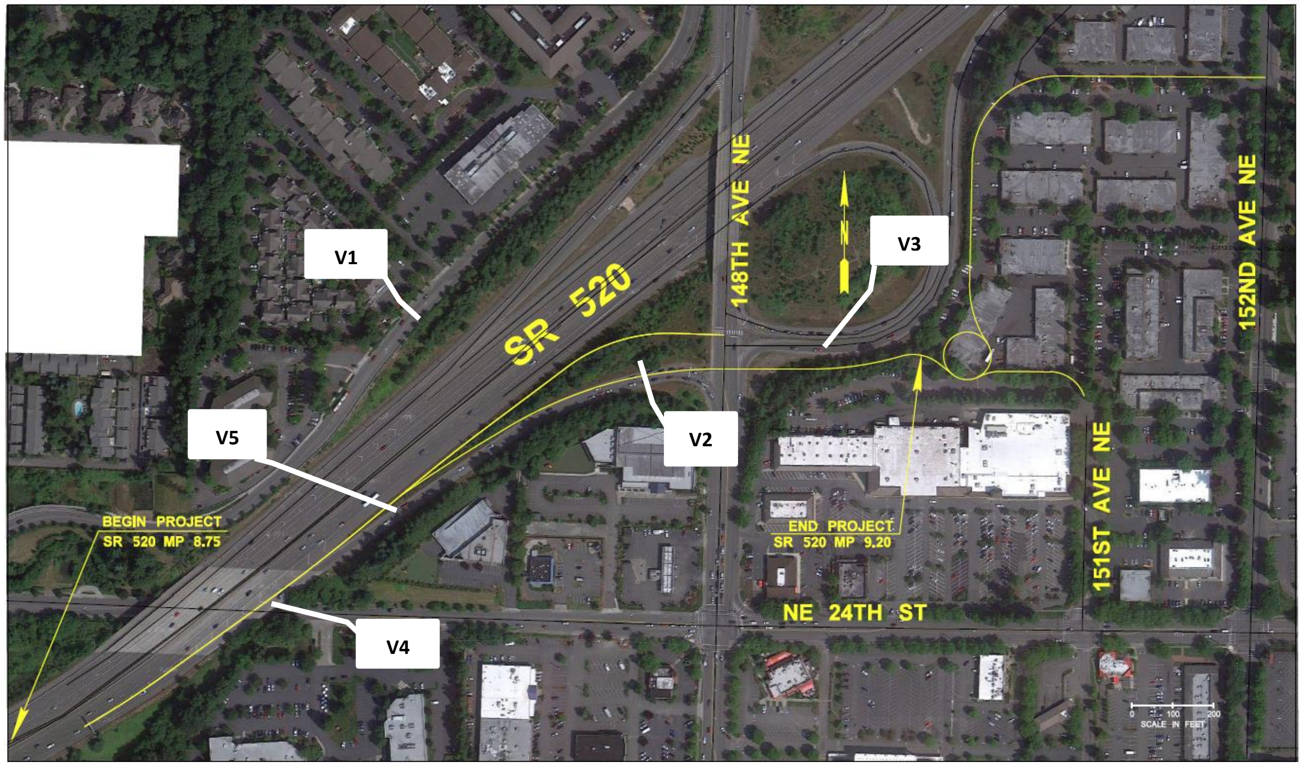
Validation receiver V5 was obtained from the ATS consulting Noise and Vibration Assessment for Bellevue Children's Academy, Elevated East Link light-rail line dated February 11, 2014.

Exhibit 5: Noise Model Validation

Receiver	Location	Date	Start Time	Measured L_{eq} (dBA)	Modeled L_{eq} (dBA)	Difference (dBA)
V1	Bike Trail on north side of WB SR 520	3/7/14	3:29 PM	75.6	73.9	-0.9
V2	EB SR 520 to 148th SB Off-ramp	2/28/14	1:59 PM	72.4	70.8	-1.2
V3	Commercial Parking on Overlake	2/28/14	2:23 PM	61.9	63.3	-1.4
V4	Side of Office Center at 24th Avenue	3/7/14	4:06 PM	66.8	65.2	-1.4
V5(*)	Bellevue Children's Academy	5/16/2013	9:00 AM	73.0	71.8	-1.5

Note(*) Memorandum 2.11.2014, page 3 of 13. ATS consulting Noise and Vibration Assessment for Bellevue Children's Academy, Elevated East Link light-rail line

Exhibit 6: Traffic Noise Measurement and Modeling Locations



Traffic Noise Modeling – Predicted Traffic Noise Levels

Additional receivers were added to the model to represent the outdoor use areas for all noise sensitive locations within the study area. The modeled receiver locations are shown in Exhibit 7.

Predicted noise levels were based on PM peak hour traffic volumes from *The Overlake access ramp at the Interchange of SR 520 and 148th Avenue NE Interchange Justification Report* (IJR Report) to estimate future noise levels (Appendix B) for the current (2015) and design, or future, year (2035) traffic with (Build) and without the project (No Build). The green symbols in Exhibit 7 indicate that the future predicted noise levels are below the FHWA Noise Abatement Criteria (NAC) impact threshold and the red symbols indicate that the receivers are above the NAC.

Exhibit 7: Traffic Noise Modeling Locations

Traffic Noise Levels

Description of Study Area

The study area is described in Exhibit 4 and modeled noise sensitive receivers are shown in Exhibit 7.

Operational Traffic Noise

Existing (2015), No Build (2035), and Build (2035) noise levels were modeled at the 17 modeling locations for the project to represent properties that could potentially be affected by the project. The modeling locations were chosen because they are representative of outdoor areas of frequent human use, such as a common ground floor outdoor use areas outside offices, playgrounds at the school, or the trail.

Predicted noise levels were based on PM peak hour traffic volumes to estimate existing conditions 2015 and future year 2035 noise levels with (Build) and without the project (No Build). Traffic information including speed, volumes, and vehicle mix data for existing and future traffic conditions with and without the project are included in Appendix B. A summary of impacts by conditions is presented here:

- Existing condition (2015), No Build (2035) and Build (2035) traffic noise impacts – 28 residential equivalents (school and trail) and 7 commercial offices.

- No substantial increase impacts under No Build (2035) and Build (2035) conditions compared to *Existing (2015) Noise Levels*

Existing modeled worst-hour traffic noise levels for the school ranges from 67 dBA to 75 dBA and the trail ranges from 73 dBA to 79 dBA (Exhibit 8). The modeled noise levels at these receivers depend on the proximity of the receiver to the existing roadways, primarily SR 520. Of the 17 total receivers, 8 receivers currently experience traffic noise levels above the NAC of 66 dBA. The 8 receivers represent 6 residential equivalents on the trail and 22 residential equivalents at the school. Existing traffic noise levels for all modeled receivers are shown in Exhibit 8.

Design Year (2035) Traffic Noise Levels – No Build
Future No Build modeled worst-hour traffic noise levels for residential areas range from 58 dBA to 80 dBA (Exhibit 8). The modeled noise levels at these receivers depend on the proximity of the receiver to the existing roadways, primarily SR 520. Of the 17 total receivers, the same 8 receivers that currently experience traffic noise levels above the NAC of 66 dBA are predicted to continue to experience traffic noise levels above the NAC of 66 dBA without the project in 2035.

The 8 receivers represent the same 28 residential equivalents and 7 commercial offices as described for impacts under existing conditions. Roadway traffic noise levels under the No Build Alternative would not result in a noticeable change over time due to the relatively small change in traffic volumes on the existing roadway network. No Build traffic noise levels in the year 2035 for all modeled receivers are within 1 to 2 dBA of existing noise levels and are shown in Exhibit 10.

Design Year (2035) Traffic Noise Levels –Build

Future Build modeled worst-hour traffic noise levels for the school range from 69 dBA to 76 dBA and at the trail they range from 74 dBA to 80 dBA (Exhibit 8). The modeled noise levels at these receivers depend on the proximity of the receiver to the existing roadways, primarily SR 520. Of the 17 total receivers, the same 8 receivers that currently experience traffic noise levels above the NAC of 66 dBA are predicted to continue to experience traffic noise levels above the NAC of 66 dBA with the project in 2035. The 17 receivers represent the same 28 residential equivalents and 7 commercial offices as described for impacts under existing conditions and No Build 2035. Roadway traffic noise levels under the Build Alternative would not result in a noticeable change over time due to the relatively small change in traffic volumes on the existing roadway network. Build traffic noise levels in 2035 for all modeled receivers are within 1 to 2 dBA of existing conditions except at one site (V3) which represents a the Overlake Commercial Parking Lot. Future Build traffic noise levels are shown in Exhibit 8.

Exhibit 8: Modeled Noise Levels

Receiver	Location	NAC (L_{eq}) (dBA)	Dwelling Units / RE's	Existing 2015 (L_{eq}) (dBA)	No-Build 2035 (L_{eq}) (dBA)	Build 2035 No Wall (L_{eq}) (dBA)	Build Vs. Existing (dBA)	Build vs. No-Build (dBA)
V3	Commercial Overlake Parking lot	72	-	66	66	70	4	4
V2	148th South bound off Ramp (Val)	72	-	**73**	**75**	**72**	-1	-3
V1	Bike Trail (Val) Rec # 4	66	1	**78**	**79**	**79**	2	0
V4	Office center at 24th Ave	72	-	69	70	70	1	0
V5	Bellevue Children's Academy Campus B	66	4	**75**	**76**	**76**	1	0
M1	14673 NE 29th PL Offices	72	-	64	65	66	1	1
M2	ICERTIS Inc., 14711 NE 29th Pl	72	-	64	65	65	1	0
M3	14455 NE 29th Pl (Residence Inn)	72	-	60	61	61	1	0
M4	Bellevue Children's Academy Main Campus	66	18	**67**	**69**	**69**	2	0
M5	15700 NE 24th St Parking lot	72	-	63	63	63	0	0
M6	2719 152nd Ave NE Redmond	72	-	64	65	65	1	0
M8	Bike Trail REC # 1	66	1	**73**	**74**	**74**	1	0
M9	Bike Trail REC # 2	66	1	**74**	**75**	**75**	1	0
M10	Bike Trail REC # 3	66	1	**76**	**76**	**76**	2	0
M11	Bike Trail REC # 5	66	1	**79**	**80**	**80**	1	0
M12	Bike Trail REC # 6	66	1	**79**	**80**	**80**	1	0
M7	14450 NE 29th Pl (ada Quest)	72	-	57	58	57	-1	-1

Impacts are noted by bolded values.

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Traffic Noise Abatement

Traffic Noise Abatement - Background

Noise abatement, including noise barrier evaluation is necessary only where frequent outdoor human use occurs and where a lower noise level would provide benefits (FHWA 1982). To be effective, the barrier must block the line-of-sight between the highest point of a noise source and the receptor. It must be long enough to prevent sounds from passing around the ends, have no openings (i.e., side streets), and be dense enough so that noise will not be transmitted through it. Intervening rows of buildings that are not noise sensitive could also be used as barriers (FHWA 1973).

Abatement was considered for this project because traffic noise impacts are predicted at 8 modeled sites. The 8 modeled sites are representative of 2 discrete areas where noise barrier placement was considered. These areas are shown in Exhibit 7 and identified by Sites V1, M8, M9, M10, M11, M12, V5 and M4.

The first of these two areas include Sites V1, M8, M9, M10, M11, and M12. These sites represent 6 residential equivalencies on the trail. V5 and M4 represent 22 residential equivalencies for the Bellevue Children's Academy. At the first area along the trail a 5 foot tall wall was evaluated. For the second location an 8 to 10 foot tall wall was evaluated. These areas where impacts are predicted were evaluated to determine if a feasible noise barrier could be constructed as described below.

Feasibility

Feasibility is a combination of acoustic and engineering considerations. All of the following must occur for abatement (e.g., noise barrier) to be considered feasible.

- Abatement must be physically constructible.
- The majority first row impacted receivers must obtain a minimum 5 dBA of noise reduction as a result of abatement (insertion loss), assuring that every reasonable effort will be made to assess outdoor use areas as appropriate.

For this project, noise barriers were evaluated at two locations as shown in Exhibit 7 to determine whether abatement could sufficiently reduce traffic noise levels. Noise barriers evaluated along SR 520 are located on the north side along the trail west of 148th Avenue and on the south side adjacent to the Children's Academy west of 148th Avenue. Each barrier evaluation described below includes consideration of multiple barrier heights and lengths in an attempt to achieve WSDOT criteria for feasibility and reasonableness.

Feasibility is described by noise reductions at each receiver for two barriers in Exhibits 9 and 10. These barrier alignments appear to be constructible. Verification of constructability will be confirmed by the project engineering office during final design.

Exhibit 9: Feasibility Analysis for Noise Wall 1

Site and Land Use Category	Dwelling Units (RE's)	Existing (L_{eq}) (dBA)	Build (L_{eq}) (dBA)	1st Row?	Min. Design Goal NW		- 10 dBA in 1st Row	
					Insertion Loss (dBA)	% 1st Row ≥ 5 dBA	Insertion Loss (dBA)	% 1st Row ≥ 5 dBA
V1 (b)	1	**78**	**79**	Yes	4.9	67 %	8.7	100 %
M8 (b)	1	**73**	**74**	Yes	6.8		8.8	
M9 (b)	1	**74**	**75**	Yes	5.2		7.4	
M10 (b)	1	**76**	**76**	Yes	4.4		7.4	
M11 (b)	1	**79**	**80**	Yes	5.8		9.9	
M12 (b)	1	**79**	**80**	Yes	3.5		8.0	
					Feasible?	Yes	*Feasible?*	Yes

Impacts are noted by bolded values.

Exhibit 10: Feasibility Analysis for Noise Wall 2

Site and Land Use Category	Dwelling Units (RE's)	Existing (L_{eq}) (dBA)	Build (L_{eq}) (dBA)	1st Row?	Min. Design Goal NW		- 10 dBA in 1st Row	
					Insertion Loss (dBA)	% 1st Row ≥ 5 dBA	Insertion Loss (dBA)	% 1st Row ≥ 5 dBA
V5 (b)	4	**75**	**76**	Yes	8.4	100 %	10.1	100 %
M4 (b)	18	**67**	**69**	Yes	5.9		6.4	
					Feasible?	Yes	*Feasible?*	Yes

Impacts are noted by bolded values.

Exhibit 11: Evaluated Noise Wall Alignment(s)

Noise Wall 1 – Sites V1, M8, M9, M10, M11, and M12
A minimum feasible barrier height of 5 feet tall and 1,568 feet long will reduce traffic noise levels by at least 5 dBA at the majority (67%) of first row receiver locations in the noise study area. Additional noise wall dimensions were evaluated as part of the reasonableness determination.

Noise Barrier 2 – Sites V5 and M4
A minimum feasible barrier height of 7 feet tall and 722 feet long will reduce traffic noise levels by at least 5 dBA at the majority of first row receiver locations in the noise study area. Additional noise wall dimensions were evaluated as part of the reasonableness determination.

Reasonableness

Since abatement is feasible at two locations (Noise Walls 1 and 2), the reasonableness of abatement was evaluated at each location. Noise walls, or other types of abatement, will only be constructed by the department if they have been determined to be reasonable by satisfying three criteria below.

1. Cost Effectiveness
The cost of noise abatement sufficient to provide at least the minimum feasible noise reductions must be equal to or less than the allowable cost of abatement for each noise wall location analyzed. Based on noise wall costs from 2007-2010, the current average costs for Washington State is $51.61. The cost is applied to the allowed wall surface area (ft^2) to generate the allowable cost per qualified resident described in Exhibit 12.

For this project, a standard noise wall design was evaluated and costs are used to describe the cost effectiveness for Noise Wall 1 and Noise Wall 2. The allowable cost per receiver, based on Build condition traffic noise levels is described in Exhibit 12.

Exhibit 12: Reasonableness Allowances

Column A Design Year Traffic Sound Decibel Level (dBA)	**Column B** Noise Level Increase as a Result of the Project (dBA)(2)	**Column C** Allowed Wall Surface Area Per Qualified Residence or Residential Equivalent	**Column D** Allowed Cost Per Qualified Residence or Residential Equivalent(1)
66		700 Sq Feet	$36,127
67		768 Sq Feet	$39,636
68		836 Sq Feet	$43,146
69		904 Sq Feet	$46,655
70		972 Sq Feet	$50,165
71	10 (substantial, step 1) (3)	1,040 Sq Feet	$53,674
72	11 (substantial, step 1)	1,108 Sq Feet	$57,184
73	12 (substantial, step 1)	1,176 Sq Feet	$60,693
74	13 (substantial, step 1)	1,244 Sq Feet	$64,203
75	14 (substantial, step 1)	1,312 Sq Feet	$67,712
76	15 (substantial, step 2)(4)	1,380 Sq Feet	$71,222

(1) Current costs based on $51.61 per square foot constructed cost developed in 2011.
(2) If the noise level increases 10 dBA or more as the result of the project (Column B), regardless of Design Year traffic sound level, follow the allowed wall surface and cost for the level of increase in Column C in lieu of the total design year sound decibel level in Column A. For total highway related sound levels at 76 or more dBA or the project results in an increase of 15 or more decibels, continue increasing the allowance at the rate provided in the table unless circumstances determined on a case-by case basis require an alternative methodology for determining allowance.
(3) Step 1 is when the noise levels are 10 to 14 dBA over Existing condition traffic noise as a result of the transportation project.
(4) Step 2 is when the noise levels are 15 or more dBA over Existing condition traffic noise as a result of the transportation project (or total highway related noise levels are between 76 and 79 decibels). Additional consideration for abatement may be considered under these circumstances.

2. Design Goal Achievement

The minimum feasibility design goal for abatement on all projects is at least 5 dBA of noise reduction for the majority of impacted front row receivers and, for reasonableness, at least 7 dBA of reduction for one receiver. Noise walls cannot be recommended if they do not achieve the design goal. In addition to the design goal requirement, WSDOT makes a reasonable effort to get 10 dBA or greater insertion loss (noise reduction) at the first row of receivers for all projects where abatement is recommended.

Exhibit 12 describes the allowable cost per receiver and the cost of the minimum barrier size to achieve the design goal. A barrier that gets 10 dBA of reduction for the majority of 1st row receivers was also evaluated.

Noise Wall 1 – Sites V1, M8, M9, M10, M11, and M12

Noise Wall 1 was evaluated along the south side of the bike trail in the same location as the existing concrete crash barrier that separates SR 520 westbound lanes from the pedestrians on the trail. This wall location was chosen for evaluation to shield SR 520 noise from the bike trail. A minimum reasonable barrier height of 5 feet tall and 1,568 feet long would achieve at least a 7-dBA noise reduction at one location behind the wall. As described in Exhibit 13, a noise barrier of this size, would achieve WSDOT's design goal of reducing traffic noise levels by at least 7-dBA. At a height of 5 feet, the barrier would cost approximately $404,622. The barrier would benefit the bike trail which has a residential equivalency of 6, which results in an allowance of $462,433. Because construction of this noise wall would require relocation of the existing ramp meter, storm sewer, electrical systems and multiple luminaries it would cost an additional $512,588 for a total cost of $970,206. Since the allowed cost is only $462,433 this wall is not reasonable and not recommended for construction.

Noise Wall 2 – Sites V5 and M4

Noise Wall 2 was evaluated at the top of the slope along the south side of the eastbound off-ramp to 148th Avenue. This wall location was chosen for evaluation to shield SR 520 noise from the playgrounds at the Bellevue Children's Academy. A minimum reasonable barrier height of 7 feet tall and 722 feet long would achieve at least a 7-dBA noise reduction at one location behind the wall. As described in Exhibit 14, a noise barrier of this size, would achieve WSDOT's design goal of reducing traffic noise levels by at least 7-dBA at the one site (Children's Academy) located behind the wall. At a height of 8 feet, the barrier would achieve our goal of a 10 dB reduction at one first row residential equivalent and cost approximately $298,099. The barrier would benefit the Bellevue Children's Academy which has a residential equivalency of 22, which results in a reasonable allowance of $1,391,400. Due to the allowable cost of Noise Wall 2 being greater than the construction cost of the barrier, Noise Wall 2 at a height of 8 feet meets WSDOT's reasonableness criteria and is recommended for placement.

Exhibit 13: Reasonableness Evaluation for Cost of Noise Wall 1 (Bike Trail)

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build (L_{eq}) (dBA)	Reasonableness Allowance		Minimum Design Goal Noise Wall		- 10 dBA in 1st Row	
				Per Modeled Receiver	Total Allowed Cost	Total Cost	Insertion Loss (dBA)	Total Cost	Insertion Loss (dBA)
V1 (b)	1	**78**	**79**	$81,752	$462,433	$404,622	4.9	$457,618	8.7
M8 (b)	1	**73**	**74**	$64,203			6.8		6.8
M9 (b)	1	**74**	**75**	$67,712			5.2		5.4
M10 (b)	1	**76**	**78**	$78,242			4.4		6.3
M11 (b)	1	**79**	**80**	$85,262			5.8		9.9
M12 (b)	1	**79**	**80**	$85,262			3.5		8.0
					Design Goal Achieved?	Yes		Yes	
					Cost Effective?	Yes		Yes	

Impacts are noted by bolded values.

Reasonableness allowance based on $51.61/ft^2

Exhibit 14: Reasonableness Evaluation for Cost of Noise Wall 2 (Children's Academy)

Site and Land Use Category	Dwelling Units	Existing (L_{eq}) (dBA)	Build (L_{eq}) (dBA)	Reasonableness Allowance		Minimum Design Goal Noise Wall		- 10 dBA in 1st Row	
				Per Modeled Receiver	Total Allowed Cost	Total Cost	Insertion Loss (dBA)	Total Cost	Insertion Loss (dBA)
V5 (b)	4	**75**	**76**	$71,222	$1,124,678	$260,836	8.4	$297,921	10.1
M4 (b)	18	**67**	**69**	$46,655			5.9		6.4
					Design Goal Achieved?	Yes		Yes	
					Cost Effective?	Yes		Yes	

Impacts are noted by bolded values.

Reasonableness allowance based on $51.61/ft^2

3. Desire for Abatement from Public within the Noise Study Area

Public involvement must occur when traffic noise abatement is recommended for Type I projects; even when public involvement is not required as part of the NEPA or SEPA processes. Public opinion must be considered when making a determination of reasonableness for traffic noise abatement. Noise abatement will not be planned if more than 50% of eligible property owners oppose the proposed noise abatement.

Recommendation for Traffic Noise Abatement

Noise abatement was evaluated at the two locations where traffic noise impacts were predicted. At both of the locations evaluated noise barriers were found to meet WSDOT Criteria for the placement of a feasible and reasonable noise barrier. Traffic noise abatement is recommended because both walls meet the criteria for placement.

The Noise Wall 1 is approximately:

- Height = 5 to 7 feet
- Length = 1,435 feet
- Cost = $457,618 (planning level cost)
- Allowed Cost = $462,433

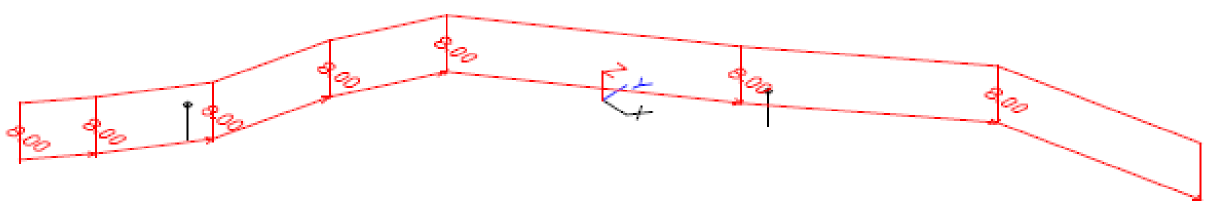
The planning level cost is less than the allowed cost and it meets the 7 dB design goal. However, because construction of this noise wall would require relocation of the existing traffic ramp meter along with utilities, electrical conduit and the upgrade of the illumination system it would cost an additional $512,588 for a total cost of $970,206. Since the allowed cost is only $462,433 this wall is not reasonable and not recommended for construction.

The Noise Wall 2 is:

- Height = 8 feet
- Length = 722 feet
- Cost = $297,921 (planning level cost)
- Allowed Cost = $1,124,678

The planning level cost is less than the allowed cost and it meets the 7 dB design goal. Since the allowed cost is greater than the planning level cost this wall is considered reasonable and recommended for construction. The planning level noise wall design is shown in Exhibits 15

Exhibit 15: Planning Level Noise Wall Design for Noise Wall 2 (Children's Academy)



XL4357 BUILD 2035	Sheet 1 of 1 25 Sep 2014
	WSDOT
Barrier View-ACADEMY	Project/Contract No. SR 520 / 148th Ave NE - Ov
Run name: 2035BUILD-JL	TNM Version 2.5, Feb 2004
Scale: <DNA - due to perspective>	Analysis By: Laura Escude

Roadway:		Ground Zone:	polygon
Receiver:		Tree Zone:	dashed polygon
Barrier:		Contour Zone:	polygon
Building Row:		Parallel Barrier:	
Terrain Line:		Skew Section:	

Construction Noise

Construction Noise Background

Construction creates temporary noise. Construction is usually carried out in reasonably discrete steps, each with its own mix of equipment and noise characteristics. For example, roadway construction involves demolition, construction, and paving.

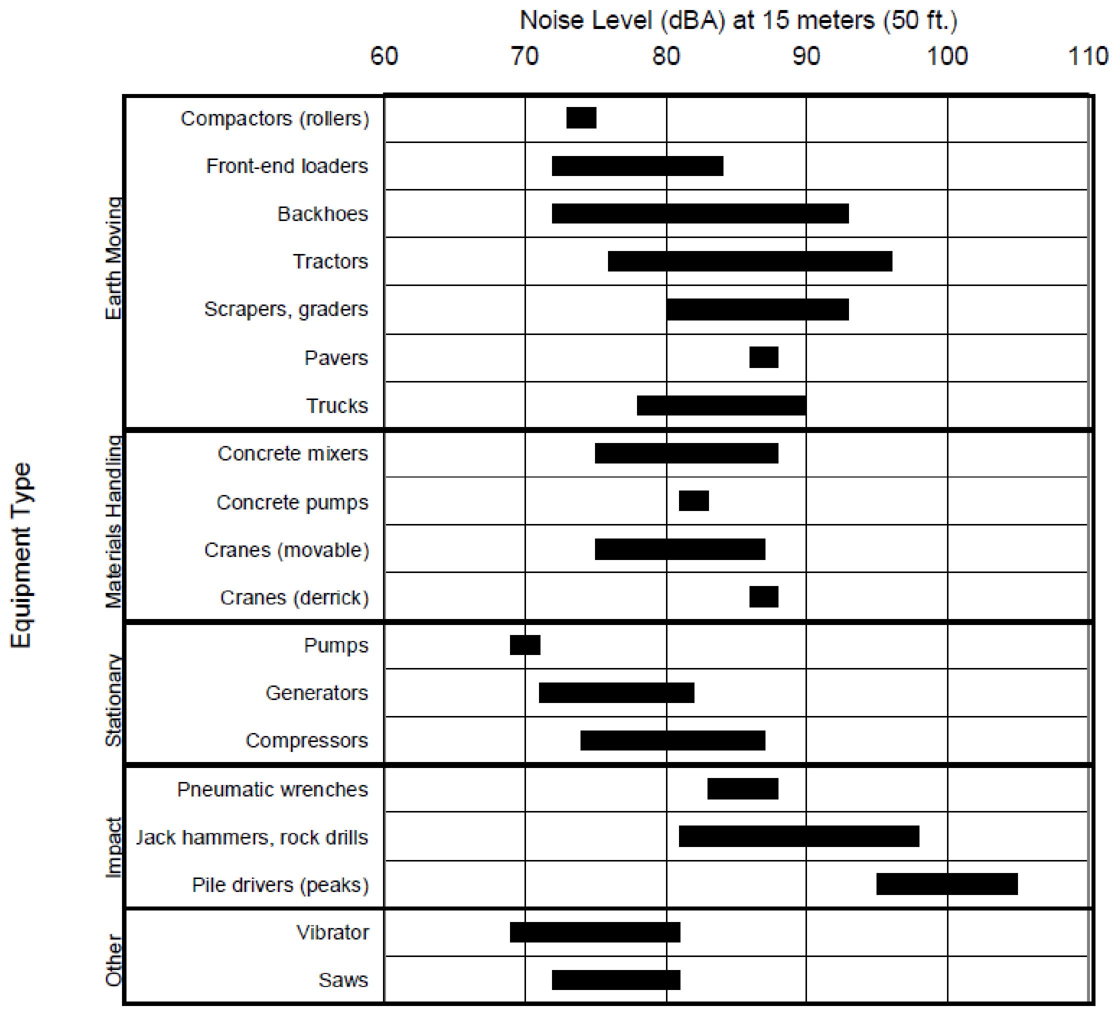
The most constant noise source at construction sites is usually engine noise. Mobile equipment generally operates intermittently or in cycles of operation, while stationary equipment, such as generators and compressors, generally operates at fairly constant sound levels. Trucks are present during most phases of construction and are not confined to the project site, so noise from trucks may affect more receivers than other construction noise. Other common noise sources include impact equipment, which could be pneumatic, hydraulic, or electric powered.

Noise levels during the construction period depend on the type, amount, and location of construction activities.

- The type of construction methods establishes the maximum noise levels.
- The amount of construction activity establishes how often construction certain noises occur throughout the day.
- The location of construction equipment relative to adjacent properties determines the effect of distance in reducing construction noise levels.

The maximum noise levels of construction equipment will be similar to the maximum construction equipment noise levels presented in Exhibit 17 and typically range from 69 to 106 dBA at 50 feet. As a point source, construction noise decreases by 6 dBA per doubling of distance from the source moving away from the equipment. The various pieces of equipment are almost never operating simultaneously at full-power and some will be turned off, idling, or operating at less than full power at any time. Therefore, the average L_{eq} noise levels will be less than the aggregate of the maximum noise levels in Exhibit 17.

Exhibit 16: Maximum Construction Noise Levels



Source: EPA, 1971 and WSDOT, 1991.

Construction Noise Levels Limits

Traffic noise and construction noise are exempt from the property line noise limits during daytime hours, but noise limits still apply to construction noise at night. Noise levels in Exhibit 18 apply only to construction noise at residential properties at “night”: between 10 p.m. and 7 a.m. At night, construction noise must meet Washington State Department of Ecology property line regulations[5] that set limits based on the Environmental Designation for Noise Abatement (EDNA) of the land use: residential (Class A), commercial (Class B), and industrial (Class C).

Allowable nighttime (10:00 PM to 7:00 AM) noise levels at Class A receiving properties (residential) are reduced by 10 dBA.

Exhibit 17: Maximum Permissible Environmental Noise Levels

EDNA of Noise Source	EDNA of Receiving Property (dBA)		
	Class A	Class B	Class C
Class A	55	57	60
Class B	57	60	65
Class C	60	65	70

Short-term exceedance of the sound levels in Exhibit 18 is allowed. During any one-hour period, the maximum level may be exceeded by:

- 5 dBA for a total of 15 minutes,
- 10 dBA for a total of 5 minutes, or
- 15 dBA for a total of 1.5 minutes[6].

The allowed exceptions are defined by the percentage of time a given level is exceeded. For example, L_{25} is the noise level exceeded 15 minutes during an hour. Therefore, the permissible L_{25} would be 5 dBA greater than the values in Exhibit 18, provided that the noise level is below the permissible level for the rest of the hour and never exceeds the permissible level by more than 5 dBA.

An hourly L_{eq} of approximately 2 dBA higher than the values in Exhibit 18 is an equivalent sound level to the permissible levels, including the short term exceedances. An L_{eq}(h) of 59 dBA corresponds approximately to a noise level of 57 dBA for 45 minutes and 62 dBA for 15 minutes, which are the maximum permissible noise levels created by a commercial source (Class B) and received by a residential property (Class A).

Construction Noise Assessment

Construction noise was qualitatively assessed and compared to Department of Ecology property line regulations and described in – City of Bellevue Municipal Code chapter 9.18.

[5] WAC Chapter 173-40

[6] WAC 173-60-040

Construction Noise Variance for Night Work

Construction noise is exempt from local property line regulations during daytime hours. If nighttime construction is required for this project, WSDOT will apply for variances or exemptions from local noise ordinances for the night work. Noise variances or exemptions require construction noise abatement measures that vary by jurisdiction. If night work is necessary for this project, noise variances are needed from the City of Seattle.

Construction Noise Abatement

Construction noise can be reduced by using enclosures or walls to surround noisy equipment, installing mufflers on engines, substituting quieter equipment or construction methods, minimizing time of operation, and locating equipment farther away from noise sensitive receivers, e.g., homes. To reduce construction noise at nearby receptors, the following abatement measures can be incorporated into construction plans and contractor specifications:

- Limiting construction activities to between 7 a.m. and 10 p.m. would reduce construction noise levels during sensitive nighttime hours
- Using haul vehicles with rubber bed-liners would reduce noise from loading trucks
- Equipping trucks with ambient backup alarms would reduce the noise for equipment backing
- Equipping construction equipment engines with adequate mufflers, intake silencers, and engine enclosures would reduce their noise by 5 to 10 dBA (U.S. EPA, 1971)
- Constructing temporary noise barriers or curtains around stationary equipment that must be located close to residences would decrease noise levels at nearby sensitive receptors

Additional methods for reducing construction noise levels that may be incorporated by the project engineering office or required by a jurisdiction include the following:

- Specifying the quietest equipment available would reduce noise by 5 to 10 dBA
- Turning off construction equipment during prolonged periods of nonuse would eliminate noise from construction equipment during those periods
- Requiring contractors to maintain all equipment and train their equipment operators would reduce noise levels and increase efficiency of operation
- Locating stationary equipment away from receiving properties would decrease noise from that equipment in relation to the increased distance

References

Beranek, L.L. 1988. Noise and Vibration Control. Institute of Noise Control Engineering. McGraw Hill.

U.S. Department of Transportation, Federal Highway Administration directive "Highway Traffic Noise: Analysis and Abatement," Revised December 2010.

U.S. Department of Transportation, Federal Highway Administration "Highway Traffic Noise: Analysis and Abatement Guidance," Revised December 2010.

United States Code of Federal Regulations (CFR) Part 772 (23 CFR Part 772), July 2010

U.S. Department of Transportation, Federal Highway Administration, 1996. *Measurement of Highway-Related Noise*. Washington D.C.

U.S. Department of Transportation, Federal Highway Administration, 1998. *FHWA Traffic Noise Model User's Guide*. Washington D.C.

U.S. Department of Transportation, Federal Transit Administration, 1995. *Transit Noise and Vibration Impact Assessment*. Washington D.C.

U.S. Environmental Protection Agency, 1971. Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances. Washington, D.C.

U.S. Environmental Protection Agency, 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. Report Number 550/9-74-004.

Washington Administrative Code, 1989. Chapter 173-60*. Maximum Environmental Noise Levels*. Olympia, Washington.

Washington State Department of Transportation, July 2011. Traffic Noise Policy and Procedures. Olympia, Washington.

APPENDIX A - Traffic Noise Analysis and Abatement Process

When are noise reports and/or recommendations final?

The noise abatement process from the preparation of a noise wall to the final noise wall design (or decision not to build) can be confusing. The following process attempts to provide some clarification to project teams and outlines a recommended "standard" process, but acknowledges that variations to this process are likely because of the differences between projects.

Environmental Discipline Reports

The noise analyst works with the project team to model project elements affecting noise that include traffic, topography, and the location of noise sensitive receivers. If traffic noise impacts are discovered through modeling, then abatement is evaluated.

Abatement is compared to the feasibility (constructability, effectiveness) and reasonableness (allowable barrier size/cost) for a "standard" project. If abatement is feasible and reasonable, the report recommends the optimal (cost to benefit) noise barrier.

The traffic noise discipline report can be finalized.

Design Phase

Design Phase and Public Involvement steps (below) may be incorporated before report is finalized.

The project office reviews the recommended noise wall height and horizontal alignment to determine if there are any conflicts that were not realized at the time the discipline report was prepared.

If conflicts from utilities, steep slopes, etc. are present, the details and costs of the conflicts are provided to the noise analyst by the project team. The noise analyst will then add any additional ("but for" the noise wall) costs to the reasonableness evaluation.
If noise wall costs including accommodation of conflicts are still less than the allowable costs for the noise wall, the barrier height and/or alignment are re-evaluated and a new barrier will be recommended. If barrier costs plus the new costs exceed the allowable costs, the barrier may not be recommended by the ANE Program.

If a noise wall is recommended, ANE Program will review and confirm noise wall dimensions throughout design process.

Public Involvement

If abatement is recommended in the Traffic Noise Discipline Report, public outreach to determine public desires for abatement must occur. The noise wall discussion may be introduced to the public before the Design Phase, but should happen after the noise wall alignment, height, and length (or other abatement description) is established so that people can understand any effects of the noise wall (or other abatement) on their community.

The final determination whether to construct a noise wall or other abatement that is recommend in the traffic noise analysis, cannot be made until public outreach has occurred.

Final Steps

Any updates to the Traffic Noise Discipline report to clarify changes that occurred during the Design Phase or from Public Involvement can be made at the project engineering offices discretion. Addendum or supplementary memorandum to clarify changes can also be added to the discipline report or project file.

The noise wall is constructed or a letter from the ANE Program is added to the project file clarifying why a noise wall was not constructed.

Appendix B – Traffic Data

Exhibit 18: Measured Traffic Volumes during Validation Measurement

Roadway	Traffic during Validation (3/7/2104)			
	Modeled Speed (mph)	Cars	Medium Trucks	Heavy Trucks
NB Off Ramp to 148th	45	684	32	1
WB On Ramp from 148th	45	228	12	1
SB 148th	35	221	9	2
NB 148th	35	1,268	36	4
SR 520 EB	60	1,624	100	28
SR 520 WB	60	1,684	92	40
SR 520 EB HOV	60	200	120	8
SR 520 WB HOV	60	248	16	4
SR 520 East Off Ramp to S. 148th	45	740	36	4
SR 520 East On Ramp from S. 148th	45	228	12	1
SR 520 EB Off Ramp to N. 148th	45	604	28	8

Exhibit 19: Modeled Hourly Traffic Volumes for Existing and future No Build and No Build Conditions

	Existing Conditions (2015)				No Build Design Year Traffic (2035)				Build Design Year Traffic (2035)			
Roadway	Modeled Speed (mph)	Cars	Medium Trucks	Heavy Trucks	Modeled Speed (mph)	Cars	Medium Trucks	Heavy Trucks	Modeled Speed (mph)	Cars	Medium Trucks	Heavy Trucks
NB Off Ramp to 148th	45	684	32	1	45	323	14	3	45	323	14	3
WB On Ramp from 148th	45	1796	76	19	45	1900	80	20	45	1900	80	20
SB 148th	35	1264	53	13	35	1441	61	15	35	1441	61	15
NB 148th	35	1245	26	13	35	2416	50	25	35	2416	50	25
SR 520 EB	60	4647	300	100	60	6405	413	138	60	6405	413	138
SR 520 WB	60	4685	252	101	60	5283	284	114	60	5283	284	114
SR 520 EB HOV	60	158	105	0	60	218	145	0	60	218	145	0
SR 520 WB HOV	60	695	58	0	60	784	65	0	60	784	65	0
SR 520 East Off Ramp to S. 148th	45	1007	42	11	45	1587	67	17	45	1587	67	17
SR 520 East On Ramp from S. 148th	45	846	36	9	45	1344	42	14	45	1344	42	14
SR 520 EB Off Ramp to N. 148th	45	-	-	-	45	808	34	9	45	808	34	9

City of Redmond, 2011. The Overlake Access Ramp at the Interchange of SR 520 and 148th Avenue NE Interchange Justification Report.

APPENDIX C – Field Data Sheets

Validation Location : V1 Bike Trail on North Side of WB SR 520 on Ramp

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
FIELD NOTE SOUND LEVEL MEASUREMENTS

SR 520 **Project** SR520/148th Ave NE Interchange - Overlake Access Ramp. **MP** 8.75 to MP 9.20 **Work Order** XL4357

Personnel: **Escude Laura /Bettie Basseri** **Date** **2/28/2014**

Metrology:

Temperature 38 Humidity 20% Cloud Cover no Wind Speed / Direction none /

Notes

Site Characteristics and Measured Levels:

Site # **V2 EB SR 520 to 148th St SB off- Ramp** Time (Start) 13:59 PM (End) 14:14

Background Level ______ Source x Auto's x Trucks x Buses x Motorcycles □ Aircraft □ Other_____ □ Other _____

Duration 15 Leq 72.4 Le ______ Lmax 87 $L_{2.5}$ 78.4 $L_{8.33}$ 75.1 L_{25} 74.2 L_{90} 67 L_{95} 66.1

Notes

Equipment:

Sound Level Meter Model / Serial Number Larson/ /2746 Mic ____________

Notes

Traffic Counts:

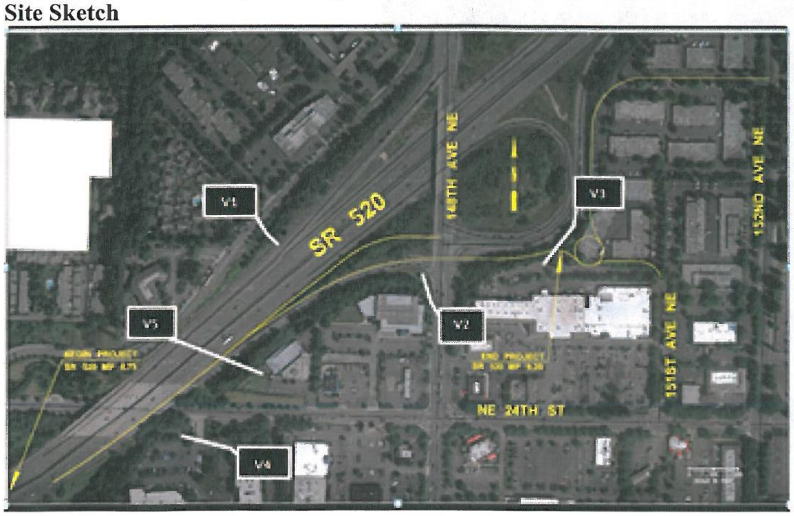
Count Location Taped see appendix B traffic data Exhibit 18

Traffic Notes

Roadway Name & Dir								
Vehicle Type	Count	Vehicle / hr.	Count	Vehicle / hr.	Count	Vehicle / hr.	Count	Vehicle / hr.
Automobiles								
Med. Trucks								
Hvy Trucks								
Busses								
Motorcycles								
Other								
Duration / *Speed								

* Speed should be Posted or Average if traffic appears to be moving at other than posted speeds

Site Sketch



Validation Location : V2 EB SR 520 to 148th St SB off- Ramp

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
FIELD NOTE SOUND LEVEL MEASUREMENTS

SR **520** Project **SR520/148th Ave NE Interchange - Overlake Access Ramp.** MP **8.75 to MP 9.20** Work Order **XL4357**

Personnel: **Escude Laura /Bettie Basseri** **Date** **3/7/2014**

Metrology:

Temperature 36 Humidity 20 Cloud Cover yes Wind Speed / Direction none/

Notes

Site Characteristics and Measured Levels:

SITE: V1 Location **Bike Trail on North Side of WB SR 520 on Ramp** Time (Start) 3:29 PM (End) 3:44

Background Level ______ Source x Auto's x Trucks xBuses x Motorcycles □ Aircraft □ Other_____ □ Other _____

Duration 15 Leq 75.6 Le ______ Lmax 87.2 $L_{2.5}$ 82.1 $L_{8.33}$ 79.8 L_{25} 75.7 L_{90} 70 L_{95} 69.1

NOTES

Equipment:

Sound Level Meter Model / Serial Number Larson/ 2746 Mic

Notes

Traffic Counts:

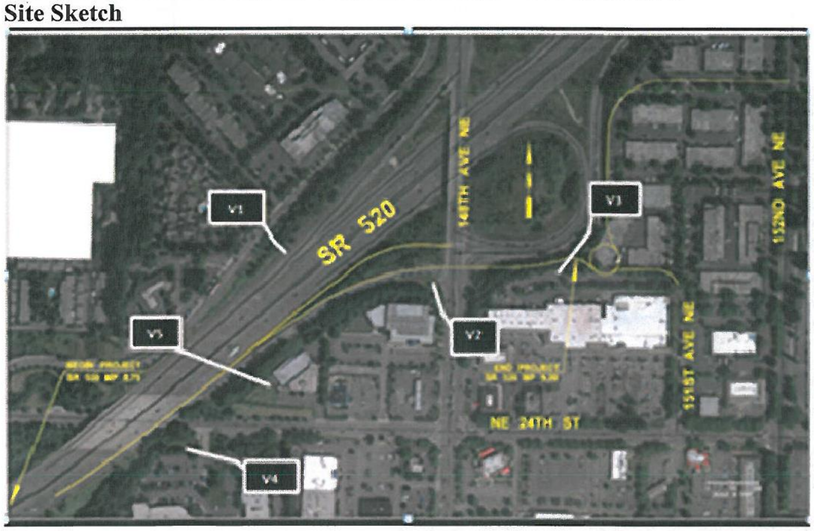
Count Location Taped see appendix B traffic data Exhibit 18 Start Time

Traffic Notes

Roadway Name & Dir.								
Vehicle Type	**Count**	**Vehicle / hr.**	**Count**	**Vehicle / hr.**	**Count**	**Vehicle / hr.**	**Count**	**Vehicle / hr.**
Automobiles								
Med. Trucks								
Hvy Trucks								
Busses								
Motorcycles								
Other								
Duration / *Speed								

*** Speed should be Posted or Average if traffic appears to be moving at other than posted speeds**

Site Sketch



Validation Location : V3 Commercial Parking on Overlake

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

FIELD NOTE SOUND LEVEL MEASUREMENTS

SR 520 **Project** SR520/148th Ave NE Interchange - Overlake Access Ramp. **MP** 8.75 to MP 9.20 **Work Order** XL4357

Personnel: Escude Laura / **Date** 3/0//2014

Metrology:

Temperature 42 Humidity 35% Cloud Cover yes Wind Speed / Direction none /

Notes

Site Characteristics and Measured Levels:

Site # **V4 South of I405 and 24th Ave Office Center** Time (Start) 16:06 PM (End) 16:21

Background Level ______ Source x Auto's x Trucks x Buses □ Motorcycles □ Aircraft □ Other_____ □ Other _____

Duration 15 Leq 66.8 Le ______ Lmax 76.1 $L_{2.5}$ 69.8 $L_{8.33}$ 68.7 L_{25} 68.3 L_{90} 64.2 L_{95} 63.4

Notes

Equipment:

Sound Level Meter Model / Serial Number Larson/ / 2746 Mic

Notes

Traffic Counts:

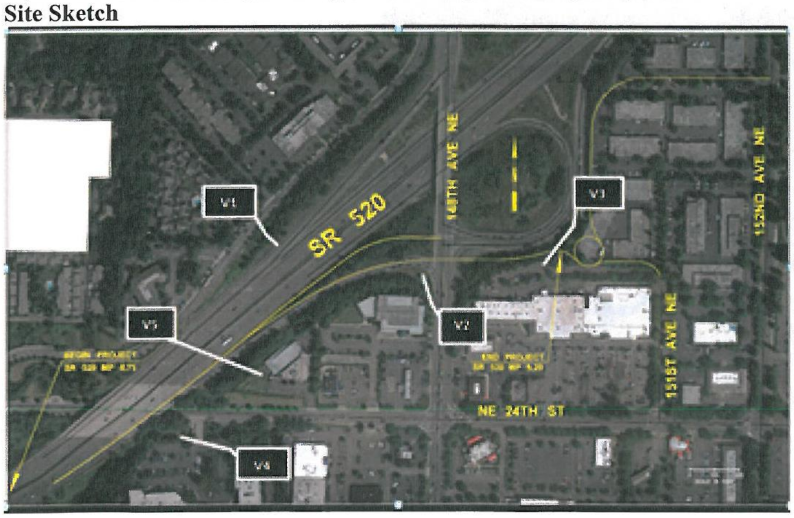
Count Location Taped see appendix B traffic data Exhibit 18 Start Time

Traffic Notes

Roadway Name & Dir								
Vehicle Type	Count	Vehicle / hr.	Count	Vehicle / hr.	Count	Vehicle / hr.	Count	Vehicle / hr.
Automobiles								
Med. Trucks								
Hvy Trucks								
Busses								
Motorcycles								
Other								
Duration / *Speed								

* Speed should be Posted or Average if traffic appears to be moving at other than posted speeds

Site Sketch



Validation Location : V4 South of I405 and 24th Ave Office Center

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
FIELD NOTE SOUND LEVEL MEASUREMENTS

SR **520** Project **SR520/148th Ave NE Interchange - Overlake Access Ramp.** MP **8.75 to MP 9.20** Work Order **XL4357**

Personnel: **Escude Laura /Bettie Basseri** **Date** **2/28/2014**

Metrology:

Temperature 40 Humidity 50 Cloud Cover no Wind Speed / Direction 0one /

Notes

Site Characteristics and Measured Levels:

Site # **V3 Commercial Parking on Overlake** Time (Start) 14:23 PM (End) 14:38

Background Level Source x Auto's x Trucks x Buses x Motorcycles □ Aircraft □ Other □ Other

Duration 15' Leq 61.9 Le Lmax 84.5 $L_{2.5}$ 64.6 $L_{8.33}$ 62.9 L_{25} 62.1 L_{90} 59.9 L_{95} 59.4

Notes

Equipment:

Sound Level Meter Model / Serial Number Larson / 2746 Mic

Notes

Traffic Counts:

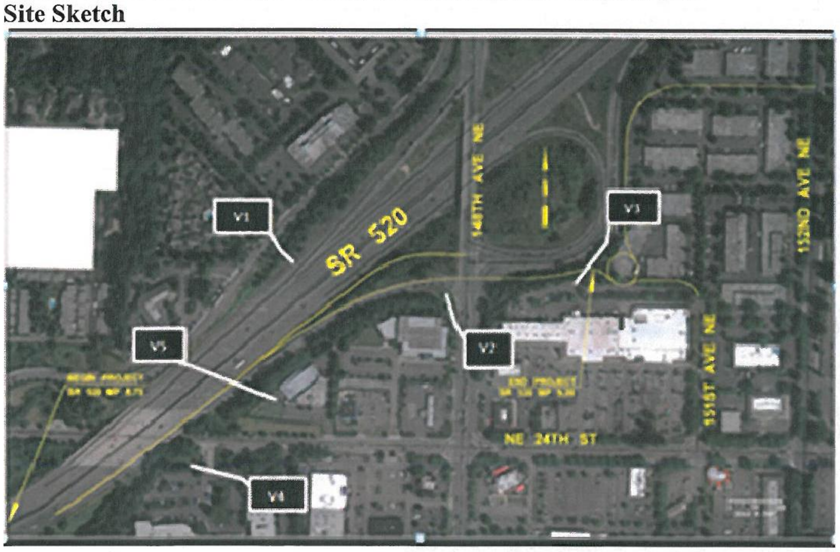
Count Location Taped see appendix B traffic data Exhibit 18 Start Time

Traffic Notes

Roadway Name & Dir.								
Vehicle Type	Count	Vehicle / hr.	Count	Vehicle / hr.	Count	Vehicle / hr.	Count	Vehicle / hr.
Automobiles								
Med. Trucks								
Hvy Trucks								
Busses								
Motorcycles								
Other								
Duration / *Speed								

* Speed should be Posted or Average if traffic appears to be moving at other than posted speeds

Site Sketch



Validation Location : V5 Bellevue Children's Academy

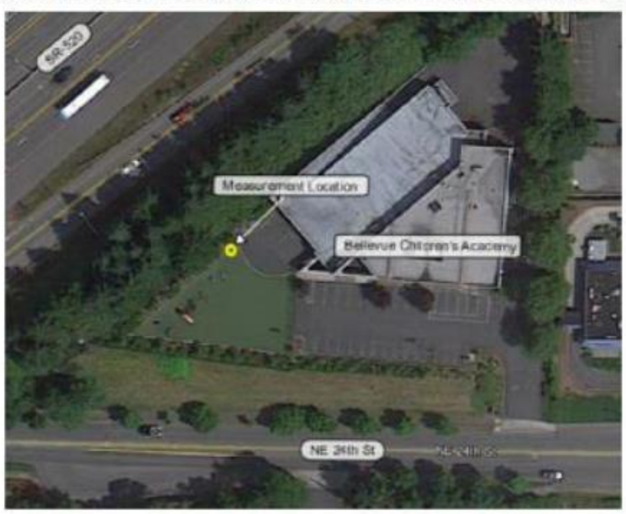
ATSConsulting
acoustics, transportation + strategy

NOISE IMPACT ASSESSMENT

Determining the existing noise exposure at noise sensitive receivers is an important step in the noise impact assessment because the thresholds for noise impacts are based on existing noise levels. ATS Consulting performed a one-hour noise measurement at the Bellevue Children's Academy on May 16, 2013 between 9 a.m. and 10 a.m. The one-hour Leq (equivalent sound level) at the Academy was 73 dBA. The microphone was located near the property line on the playing area near NE 24th Street, as shown in Figure 2. The primary noise source at the school was traffic from SR-520. The measured noise levels are plotted in Figure 3. The louder noise levels in the last 10 minutes of the measurement are from students coming out into the play area.

The Bellevue Children's Academy is a Category 3 Land Use, which applies to institutional land uses such as schools and churches. For a Category 3 land use with an existing noise level of 73 dBA, the moderate noise impact threshold is 70 dBA and the severe noise impact threshold is 77 dBA.

Figure 2: Aerial Photograph Showing Noise Measurement Location



ATSConsulting
acoustics, transportation + strategy

Draft: Noise and Vibration Assessment for Bellevue Children's Academy, Elevated Project
February 11, 2014
Page 2

Figure 3: Measured Noise Levels at the Bellevue Children's Academy